

10/568490

WO 2005/019843

PCT/FR2004/002154

AP20 Rec'd PCT/PTO 15 FEB 2006

DEVICE FOR CONTROLLING THE SPECIFIC ABSORPTION RATE OF
MASS-PRODUCED RADIANT OBJECTS

5 The present invention pertains to the control
(monitoring) of the specific absorption rate, also
termed the SAR, of mass-produced radiant objects and in
particular of portable telephones.

10 It is known that the level of exposure to electro-
magnetic waves of users of portable telephones is fixed
by standards which generally define the maximum
acceptable SAR for a mass of given biological tissue.

15 In this regard, standards exist in particular in
Europe, the United States and Japan.

However, the measurement procedures which are defined
by these standards are relatively complex and irksome
to implement.

20 Generally, these standards provide that the integrated
maximum SAR, denoted or $\langle \text{SAR} \rangle$, be calculated on the
basis of a plurality of measurements of electric field
in a homogeneous phantom reproducing conditions very
25 much like those of the biological media corresponding
to the human body.

Thus, for example in Europe, the volume explored is
about a cube of side 2 cm and the sampling interval is
30 a few millimeters, so that the number of measurements
to be performed is of the order of several hundred.
These measurements must moreover be repeated for at
least two positions of the portable telephone with
respect to the phantom, on either side of the latter,
35 as well as for at least three frequencies (or six for
dual-band portables).

It is therefore understood that the protocols proposed by these standards documents are especially lengthy and that it is inconceivable to test in this way all portable telephones which may be placed on the market.

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There therefore exists a need for a test allowing rapid control (monitoring) of these portable telephones at the end of production.

10 For this purpose, the invention proposes a device for controlling the specific absorption rate of mass-produced radiant objects, characterized in that it comprises at least one sensor for measuring a power radiated by an object situated at the level of said
15 zone and at least one processing unit which analyzes the power thus measured, the sensor comprising a waveguide exhibiting an opening disposed opposite the test zone and at least one measurement probe disposed inside said waveguide.

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Such a device is advantageously supplemented with the following various characteristics taken alone or according to all their technically possible combinations:

25 - it comprises means for conveying the objects up to the test zone.

- the sensor furthermore comprises a phantom in a material having dielectric properties similar to those of biological tissues, and in which the waveguide is
30 immersed.

- the phantom is of cylindrical or more complex shape.

- the waveguide is of rectangular or circular cross section, which can optionally be varied to form a horn.

35 - the waveguide is a horn.

- the sensor comprises at least two orthogonal probes placed inside the waveguide.

- the waveguide comprises two pairs of orthogonal probes.

- the two pairs of probes are linked to processing means, allowing in particular deviometry to be implemented.
- the processing unit instructs the displaying on a
5 screen of a curve whose amplitude and extent are dependent on the radiated power measured by the sensor and whose position is dependent on the deviometry measurements.
- the device comprises an array of several sensors
10 exhibiting various orientations.
- in the case where the radiant objects are cellular communication terminals, it comprises upstream of the test zone a base station simulator.
- the device comprises upstream of the sensor or
15 sensors guiding means able to impose a certain positioning on the radiant objects.
- the processing unit stores matches between values of integrated specific absorption rates and values of electrical powers, these matches being determined
20 beforehand by calibration.

Advantageously also, tests are implemented in the course or at the end of production by sampling objects from the production plant and analyzing them in a
25 shielded and anechoic container containing a sensor or an array of waveguide sensors and measurement probes.

Other characteristics and advantages of the invention will become further apparent from the description which
30 follows, which is purely administrative and nonlimiting and should be read in conjunction with the appended drawings in which:

Figure 1 illustrates a test zone equipped with a device
35 in accordance with a possible embodiment of the invention.

Figure 2 diagrammatically illustrates a possible exemplary sensor.

Figure 3 diagrammatically illustrates another possible exemplary sensor.

- 5 Figure 4 illustrates the use of a plurality of sensors distributed in an arch.

Figures 5a and 5b are diagrammatic cross-sectional representations of sensors with four probes in the case
10 on the one hand of a waveguide sensor of circular cross section (figure 5a) and on the other hand of a waveguide sensor of square cross section (figure 5b).

Figure 6 is a diagram illustrating the principle of a
15 deviometry arrangement embodied with a four-probe sensor.

Represented in figure 1 is a zone which is disposed for example at the end of a line for manufacturing portable
20 telephones 1 and which is equipped with a device making it possible to test the integrated SAR of the telephones produced.

The portable telephones 1 are transported thereto on a
25 conveyor belt 2 which causes them to pass through said test zone.

This test zone comprises in particular one or more sensor(s) 3 which are disposed opposite or near the
30 conveyor belt 2, above and/or below the latter, and which make it possible to measure the integrated SAR. The sensor or sensors 3 are linked to a processing unit 4. They are disposed, with respect to the direction of drive of the conveyor belt 2, downstream of a base
35 station simulator 5.

The role of the simulator 5 is to activate the portable telephones 1 which arrive in the test zone so that they are in a state where they emit their maximum power P_{max}

when they are at the level of the test zone and when they travel past the sensor or sensors 3.

5 Guiding ramps 6 are disposed just above the conveyor belt 2, upstream of the test zone, and make it possible to force the portable telephones to orient themselves in a predefined manner, for example in such a way that their longitudinal axis coincides substantially with the axis along which they are driven by said conveyor
10 belt 2 when they are in the test zone.

An exemplary sensor 3 will now be more precisely described with reference to figures 2 and 3.

15 This sensor 3 comprises a metal structure 7 which defines a waveguide which is able to guide the electromagnetic waves so as to control their propagation up to at least two orthogonal detection probes 8 and 9, which make it possible to measure the electric field in two
20 directions of polarization.

The electric field thus measured is transmitted to the processing unit 4 which determines the electrical power which corresponds to the field thus measured along two
25 directions of polarization. A simplified procedure may be envisaged in which one merely measures the predominant component of the electric field whose state of polarization will have been analyzed previously. In this case it suffices to measure this component alone
30 of the field through a suitable orientation of the sensor.

In the case illustrated in figure 2, the waveguide 7 is of cylindrical shape.

35 Advantageously also, as illustrated in figure 3, this waveguide 7 may be a horn waveguide, so as to make it possible to confine the waves while allowing integration over a maximum entrance area.

This waveguide 7, be it cylindrical, horn-shaped or the like, is immersed in a material filling a phantom 10 whose dielectric properties correspond to those of biological tissues.

The material is advantageously an equivalent liquid.

The phantom is for example of comparable shape to the shapes customarily proposed in standards documents (generic phantoms of simple shape (spheres in particular) or anthropomorphic phantoms).

For example, as illustrated in figures 2 and 3, it may be of cylindrical shape.

In this case, a saving is made in terms of bulk, complexity of embodiment and cost.

It will be noted in this regard that reduced bulk allows the construction of arrays of juxtaposed probes.

This is the particular case illustrated in figure 4 in which is represented an array of sensors 3 disposed in an arch around the zone through which the portable telephones 1 pass.

Such an array of arch-like probes makes it possible to tolerate a certain absence dispersion of alignment of the portable telephones with respect to the principal axis of displacement of the belt and to vary the test configurations.

It will be noted that the waveguide 7 of a sensor of the type of those illustrated in figures 2 and 3 is disposed at a distance fairly close to the antennas of the portable telephones as in a regular test, typically of the order of a few mm to a few cm.

Moreover, such a sensor 3 advantageously comprises, as illustrated by figures 5a and 5b, not two probes but four orthogonal probes. The use of four probes or antennas allows, in fact, deviometric measurements making it possible to supply information regarding the location and the extent of the zone or "spot" of dissipation, of power in the phantom.

For this purpose, use is advantageously made, as illustrated in figure 6, of 3dB - 180° couplers (referenced by 11) making it possible to calculate the sums and differences of the amplitudes of the field measured by the probes along on the one hand a first axis (X axis) and on the other hand a second axis (Y axis). These sum and difference signals are themselves sent to the processing unit 4 where they are analyzed so as to deduce therefrom the SAR and complementary information regarding the position and/or the orientation of the portable telephone 1 as well as regarding possible malfunctions.

Specifically, this deviometric measurement allows position control (monitoring) of the telephones under test and may turn out to be useful in the diagnosis afforded for any difference between the measurements observed on a telephone and the reference measurements with which it ought to match up. It also affords a better assessment of the extent over which the power is distributed.

Provision is furthermore advantageously made for the processing unit 4 to display on a screen a spot whose intensity and extent are dependent on the electrical power measured and whose position will be that deduced from the intensities of the deviometry curves.

The information regarding the measurement of integrated field, measured with the device just described is advantageously used to deduce therefrom, using the

prestored match-up tables, the integrated <SARs> of the portable telephones analyzed.

For this purpose prior use is made of calibration
5 procedures making it possible to match up the field measurements performed by the sensor and portable telephone integrated SARs such as measured in a standardized measurement bench.

10 The <SAR> is in fact very tightly correlated with the power dissipated in the phantom, which power depends essentially on the phantom used (shape, dimensions, dielectric characteristics, etc.), on the portable
15 telephone (type of antenna, coupling of the housing, etc.), on the relative position of the portable with respect to the phantom.

The use of a waveguide sensor makes it possible to integrate the power flux through its opening and in
20 this way to make an overall measurement of the power dissipated in the phantom, which power, for a given type of telephone and type of phantom for a relative position of the telephone with respect to the phantom, may be directly linked, through a match-up table, to a
25 value of <SAR>.

It will also be noted that the device can also be placed in a shielded and anechoic container containing a sensor or an array of waveguide sensors and
30 measurement probes. Such a container makes it possible to implement tests by sampling objects from the production plant.

It may be used alone or as a supplement for sensors
35 disposed alongside the conveying plant, for example with a view to a more thorough test.

This test device just described has numerous advantages.

It allows a fast test procedure (several telephones per minute).

- 5 It yields a real-time indication of compliance and/or an estimate of <SAR> allowing sorting on the radiant objects (telephones or the like) produced and possibly an indication of diagnosis with a view to possible recycling.
- 10 It is cheap.
- It is noninvasive.
- 15 It is easy to integrate into a manufacturing line.

It requires a reduced number of probes, typically 2 to 4.